

Hyperloop Transportation System Using Electromagnetism

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Abstract - The conventional modes of transportation consists of four unique types and that are rail, road, water, and air. These modes of transport tend to be either slow, expensive or a combination of both. Hyperloop is a new mode of transport that seeks to change this pattern by being both fast and inexpensive for people and goods. Hyperloop is a proposed mode of passenger and freight transportation that propels a capsule-like vehicle through a near-vacuum tube at more than airline speed. The capsule would accelerate to cruising speed gradually using a linear electric motor and glide above their track using passive magnetic levitation created by the copper coil, which is controlled by micro controller. Hyperloop consists of a low-pressure tube with capsules that are transported at both low and high speeds throughout the length of the tube. The capsules are supported on a cushion of air, featuring pressurized air and aerodynamic lift. Passengers may enter and exit Hyperloop at stations located either at the ends of the tube, or branches along the tube length. It quickly becomes apparent just how dramatically the Hyperloop could change transportation, road congestion and minimize the carbon footprint globally. With the Hyperloop, extremely fast, inexpensive intercity travel would be widely accessible. If both people and goods can move more quickly and comparatively cheaply, rapid growth is a logical outcome.

Key Words: Hyperloop, Microcontroller, Vacuum Tube, Capsule, Relay, Bluetooth.

1. INTRODUCTION

A Hyperloop is a proposed mode of passenger and/or freight transportation, first used to describe an open-source vac train design released by a joint team from Tesla and SpaceX. Drawing heavily from Robert Goddard's vac train, a Hyperloop is a sealed tube or system of tubes through which a pod may travel free of air resistance or friction conveying people or objects at high speed while being very efficient. Elon Musk's version of the concept, first publicly mentioned in 2012, incorporates reduced-pressure tubes in which pressurized capsules ride on air bearings driven by linear induction motors and air compressors. The Hyperloop Alpha concept was first published in August 2013, proposing and examining a route running from the Los Angeles region to the San Francisco Bay Area roughly following the Interstate 5 corridor. The paper conceived of a Hyperloop system that would propel passengers along the 350-mile (560 km) route

at a speed of 760 mph (1,200 km/h), allowing for a travel time of 35 minutes, which is considerably faster than current rail or air travel times. Preliminary cost estimates for this LA-SF suggested route were included in the white paper US\$6 billion for a passenger-only version, and US\$7.5 billion for a somewhat larger-diameter version transporting passengers. The vehicles although transportation analysts had doubts that the system could be constructed on that budget; some analysts claimed that the Hyperloop would be several 1 billion dollars over budget, taking into consideration construction, development and operation costs. The Hyperloop concept has been explicitly "open-sourced" by Musk and SpaceX, and others have been encouraged to take the ideas and further develop them. To that end, a few companies have been formed, and several interdisciplinary student-led teams are working to advance the technology. SpaceX built an approximately 1-mile-long (1.6 km) subscale track for its pod design competition at its headquarters in Hawthorne, California. Some experts are sceptical, saying that the proposals ignore the expenses and risks of developing the technology and that the idea is "completely impractical". Claims have also been made that the Hyperloop is too susceptible to disruption from a power outage or terror attacks to be considered safe. Hyperloop Transportation Technologies are in process to sign a Letter of Intent with the Indian Government for a proposed route between Chennai and Bengaluru. If things go as planned, the distance of 345 km could be covered in 30 minutes. HTT also signed an agreement with Andhra Pradesh government to build India's first Hyperloop project connecting Amaravathi to Vijayawada in a 6-minute ride. On February 22, 2018, Hyperloop One has entered into a MOU (Memorandum of Understanding) with the Government of Maharashtra to build a Hyperloop transportation system between Mumbai and Pune that would cut the travel time from the current 180 minutes to just 20 minutes.

2. Block Diagram

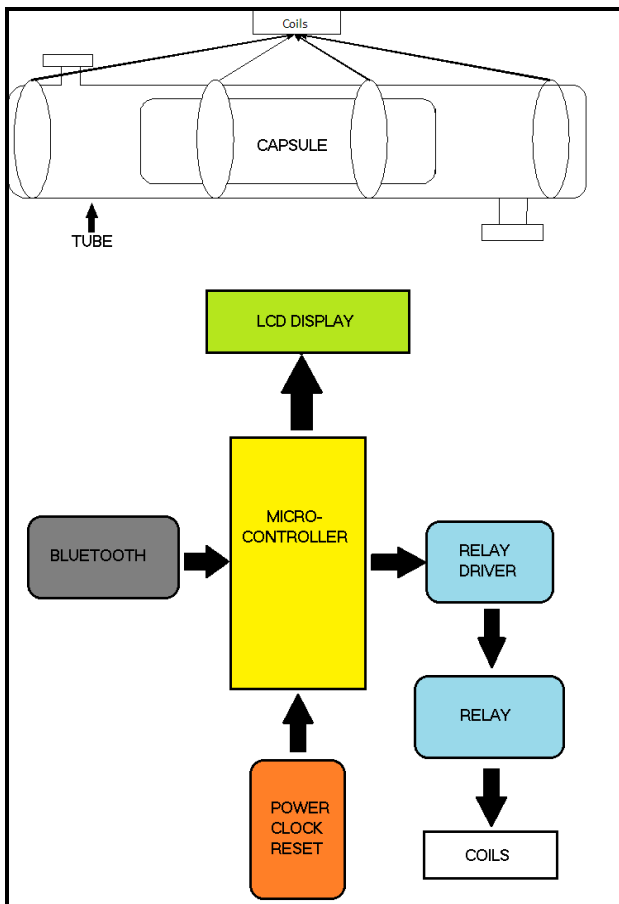


Fig -1: Block Diagram of Hyperloop Transportation system

Hyperloop system works on electromagnetism concept. In that, hollow vacuum tube encloses the traveling prototype capsule that is made up of Ferromagnetic material. It will be accelerated by applied the electromagnetic force at very High speed nearly 500 to 600km/hour at such high speed to minimize the resistance force of air it is necessary to maintain vacuum in the hollow carrier Hyperloop tube, in mega project such as the Project which is in progress the Mumbai to Pune Hyperloop project. Here in our project we are going to make a small prototype of Hyperloop system. We have used PVC pipe as a hollow tube we have installed two exhaust fans at both ends to suck out the air from PVC pipe. We have made slot at the top of the PVC pipe so we can see the position of projectile, which has to be propelled by using electromagnetic force. The capsule is placed at one end and the PVC pipe is enclosed by 3 copper coils, is coil will have 1-ohm resistance and approximately 150 turns. These three coils are connected parallel with 24-volt DC supply. This coils require minimum 18 to 24 DC volt supply to generate sufficient electromagnetics force that will easily propel the electromagnetic capsule. We have arranged three coils one after another by keeping some space in between them. At initial stage coil, one will be activated by applying 24-volt DC supply but where to apply a pulse of current so that the coil

be excited for few milliseconds for example 25 milliseconds. If in a case, we have applied continuous current supply to the coil the coil will generate electromagnetic force and will attract the ferromagnetic capsule towards it. But it will not let go the capsule further ahead because of its back EMF it will held the capsule at the center of the coil, so to avoid that back EMF we have to apply a pulse of current. As soon as the ferromagnetic capsule will reach at the center of the coil, we have to disconnect the power supply of that coil and in the same time, we have to activate the second coil. It will attract the ferromagnetic capsule towards it and the same phenomenon will be applied as per the first coil. Third coil will be activated after the second coil but the power supply to the third coil will be kept continuous so that it will attract the capsule towards itself and will held the capsule at the final position. To achieve this mechanism we need a timer that will shortly turn on the coil and turn off the coil at the desired moment so that the proper mechanism of Hyperloop system will be achieved. We are using a microcontroller, which has to be programmed as per our requirement, Bluetooth remote control for that we will use a Bluetooth application in a smartphone that will give command to the microcontroller like start and stop forward and backward movement as per the requirement will operate the microcontroller circuit. To get the 24-volt DC supply we are using four batteries each of 6 volt and 4.5 ampere hour rating. They will deliver sufficient power to the coil to drive the capsule. We will connect these four batteries in series so that addition of four batteries will lead the overall voltage of 24 volt and that total 24-volt power is directly applied to the coil by using relay switch, which will be SPDT (single pole double throw) switch. These relay will be operated by relay driver IC that require 12 volt DC supply that we can take by tapping two series connection of batteries, but the microcontroller circuit will run on 5 volt dc supply only. To get 5-volt dc supply we will use IC 7805 by using this IC 7805, we can convert 12-volt dc supply to 5-volt dc supply and this 5-volt dc supply can be applied to the microcontroller circuit. The microcontroller will be interfaced with 16x2 LCD display to monitor or debug the operation; the microcontroller is also interfaced with Bluetooth module to receive the commands sent from the Bluetooth transmitter, which is previously installed on the smartphone. We will design a basic Bluetooth control application that will be run on smartphone, which is Android, based and will be used to operate the project.

2.1 Circuit Diagram

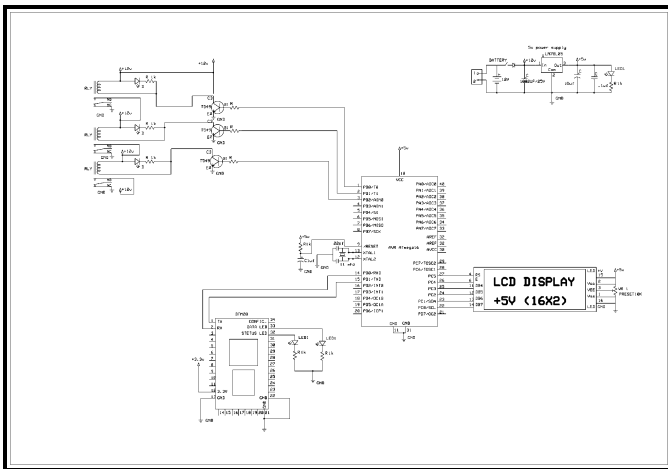


Fig -2: Circuit Diagram of Hyperloop Transportation system

Hyperloop project is based on the microcontroller to control the whole the system. The microcontroller used is AtMega 16 AVR microcontroller. It has a 16 kb of memory. It is a 40 pin IC. To work the microcontroller we need power supply, clock and reset. At pin 10 Vcc is applied Pin no.11 and 31 is connected to ground. Pin no. 12 and 13 is connected to the crystal oscillator which has the frequency of 11.590Mhz which is coupled with the 2 22 microfarad capacitor pin no. 9 is a reset pin which is power on reset.

When we on the device the microcontroller will be reset and it will start from zero memory location. The microcontroller has four ports name as port A, port B port C and port D. All pin are bidirectional pins. For communication with the system, we will be using Bluetooth device. The first two pin of Port D are RX and TX for serial communication. The Bluetooth devices name as HC 05 is connected to the microcontroller. The Bluetooth devices has Vcc with +5v, ground pin is grounded and antenna pin is connected to build in strip line antenna. The RX and TX of the Bluetooth is connected to the microcontroller. The Bluetooth model operates on the frequency 2.4 GHz and for serial communication, the baud rate is 9600. The Bluetooth has the range of 10m and it is a class 1 module. To display the received data from the mobile LCD display is coupled with microcontroller. LCD display is off 16 characters and 2 rows. The Vcc pin of display is connected to +5v supply, ground pin is connected to ground and contrast pain is connected to variable resistor to control brightness of the LCD. There are three more pins RS, R/W and enable. Data command and enable is connected to microcontroller .R/W is connected to ground. To write a data on LCD .LCD has 8 pins D0 to D7. We will be using only 4 pins D4, D5, D6, and D7. In which 4-bit data is send twice and in combine, we get 8-bit data. So on the whole display is mounted on single port. Port B is act as output port. The output of the microcontroller is very weak

so to amplify transistor is used. The output of microcontroller is connected to base of transistor an emitter is connected to ground and the collector house transistor is connected to relay contactor. Relay will be of 12 volt electromagnetic SPDT. The relay has two set of contacts normally open I normally closed. The coils of Hyperloop is given with external power supply of 18 V to 24 v and other end is connected to the relay contactor.

3. Components

3.1 Microcontroller

ATmega16 is an 8-bit high performance microcontroller of Atmel's Mega AVR family with low power consumption. Atmega16 is based on enhanced RISC (Reduced Instruction Set Computing, Know more about RISC and CISC Architecture) architecture with 131 powerful instructions. Most of the instructions execute in one machine cycle. ATmega16 can work on a maximum frequency of 16MHz. ATmega16 has 16 KB programmable flash memory, static RAM of 1 KB and EEPROM of 512 Bytes. The endurance cycle of flash memory and EEPROM is 10,000 and 100,000, respectively. ATmega16 is a 40-pin microcontroller. There are 32 I/O (input/output) lines, which are divided into four 8-bit ports designated as PORTA, PORTB, PORTC and PORTD. ATmega16 has various in-built peripherals like USART, ADC, Analog Comparator, SPI, JTAG etc. Each I/O pin has an alternative task related to in-built peripherals. The following table shows the pin description of ATmega16.

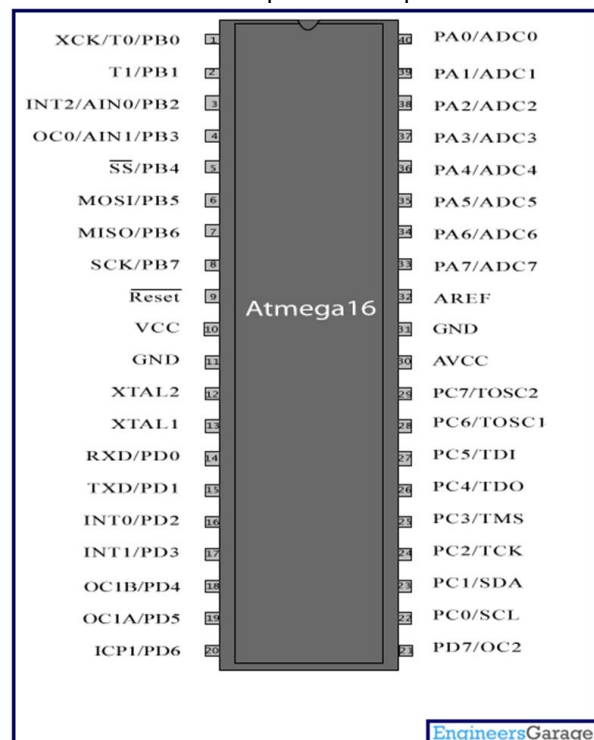


Fig -3: Atmega 16 Microcontroller

3.2 Bluetooth Module

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Blue core 04-External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature). It has the footprint as small as 12.7mmx27mm. Hope it will simplify your overall design/development cycle.

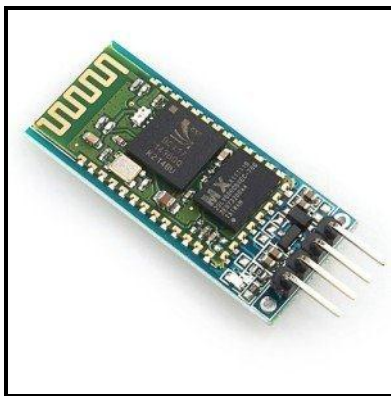


Fig -4: HC 05 Bluetooth Device

3.3 L.C.D. Display

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD, each character is displayed in 5x7-pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Click to learn more about internal structure of a LCD. Sample paragraph Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, SC, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.



Fig -5: L.C.D Display

3.4 Relay

A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism, but other operating principles are also used. Relays find applications where it is necessary to control a circuit by a low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits, repeating the signal coming in from one circuit and re-transmitting it to another. Relays found extensive use in telephone exchanges and early computers to perform logical operations. A type of relay that can handle the high power required to directly drive an electric motor is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems, digital instruments still called "protection relays perform these functions

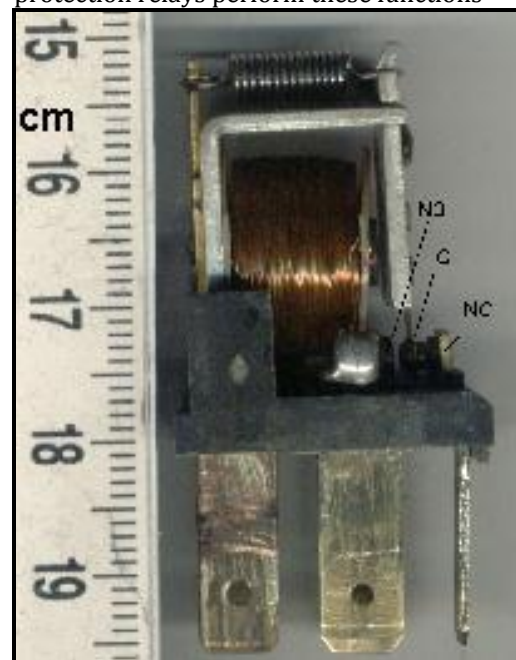


Fig -6: Relay

3.5 Tube

The tube is a PVC Pipe of diameter 10 inch and 5 feet long. The Capsule travels from one end to the other inside the tube.

3.6 Capsule

The Capsule is made up of Iron material that interacts with the magnetic field created by the coils. It will be of 6-8 inches. In Practical, it is used to carry Passenger or goods.

3.7 Coils

The coils used in this project are copper coils. SWG= 18. It will be wound on the tube approximately of 150 turns. There will be 3 coils placed at equal distance from each other.

4. CONCLUSIONS

A high-speed transportation system known as Hyperloop has been developed in this project. We have created a prototype of Hyperloop in this project by using PVC pipe and magnetic coils. The activation and deactivation of the coils is done by using relay and micro-controller. The Hyperloop works on the principle of electromagnetism.

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